PSYCHOLOGY AND PSYCHIATRY

HIGH SLEEP REACTIVITY: CLINICAL, PSYCHOLOGICAL AND POLYSOMNOGRAPHIC FEATURES

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ABSTRACT

Background. *The model of sleep reactivity to stress considers sleep reactivity to stress as a link in the pathogenesis of insomnia disorder – the degree to which stress disturbs sleep, which manifests as difficulty in initiating and maintaining sleep.*
The aim. *To study clinical and psychological features as well as subjective and objective sleep indexes of subjects with high level of sleep reactivity to stress.*
Materials and methods. *The psychological status, subjective indexes of sleep and sleep reactivity to stress according to Ford Insomnia Response to Stress Test were studied among 18–75 year-old subjects without significant sleep disturbances and patients with chronic insomnia. Polysomnography was performed for objective evaluation of sleep parameters.*
Results. *It was found that individuals with high levels of sleep reactivity to stress were characterized by high levels of anxiety, restlessness, and neuroticism. According to results of Pittsburg questionnaire, a lower quality of sleep was revealed. These findings were correlated with objective indexes of sleep according to polysomnographic studies: less deep sleep and its lower efficiency due to sleep disturbances.*
Conclusions. *Individuals with high sleep reactivity to stress are characterized by greater anxiety combined with subjective and objective sleep disturbance like insomnia type.*

Key words: *insomnia, sleep reactivity, anxiety, polysomnography, sleep efficiency*

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КЛИНИКО-ПСИХОЛОГИЧЕСКИЕ И ПОЛИСОМНОГРАФИЧЕСКИЕ ОСОБЕННОСТИ ЛИЦ С ВЫСОКОЙ РЕАКТИВНОСТЬЮ СНА К СТРЕССУ

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РЕЗЮМЕ

Обоснование. *Модель реактивности сна к стрессу рассматривает в качестве звена патогенеза инсомнического расстройства реактивность сна к стрессу – степень, в которой стресс нарушает сон, что проявляется в виде трудностей инициации и поддержания сна.*
Цель работы*. Изучить клинико-психологические особенности, а также субъективные и объективные показатели сна испытуемых с высоким уровнем реактивности сна к стрессу.*
Методы. *Среди респондентов 18–75 лет без значимых жалоб на нарушения сна и среди пациентов с хронической инсомнией оценён психологический статус, субъективные показатели сна и реактивность сна к стрессу по опроснику Форда по влиянию стресса на сон (Ford Insomnia Response to Stress Test), а также проведена полисомнография для объективной оценки показателей сна.*
Результаты. *Установлено, что для лиц с высоким уровнем реактивности сна к стрессу характерны высокие уровни тревожности, тревоги, невротизации. По результатам Питтсбургского опросника выявлено более низкое качество сна. Эти данные согласуются с объективными показателями сна по результатам полисомнографического исследования: менее глубоким сном и его меньшей эффективностью за счёт нарушения поддержания сна.*
Заключение. *Лица с высокой реактивностью сна к стрессу характеризуются большей тревожностью в сочетании с субъективным и объективным нарушением сна по типу инсомнии.*

Ключевые слова*: инсомния, реактивность сна к стрессу, тревога, полисомнография, эффективность сна*

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OBJECTIVES

Insomnia is a condition that characterized by subjectively unsatisfactory quality or duration of sleep associated with difficulties of falling asleep, sleep maintenance disorders, and/or early (unintentional) awakenings 3 times a week with impaired daytime functioning or more when there are opportunities for comfortable sleep [1]. Along with the most commonly used models of the aetiopathogenesis of insomnia, the "three P's" model and the hyperactivation model, a new concept – sleep reactivity to stress – is currently being used [2]. Sleep reactivity to stress is regarded as a complex feature determined both genetically and by environmental influences, which manifests itself in a propensity to produce sleep disturbances in response to exposure to various stressors [2, 3]. Research is needed in order to determine whether the sleep reactivity to stress factor may be a risk marker for the development of insomnia, as reliable premorbid predictors for the development of this variant of insomnia have not been determined to date.

THE AIM OF THE STUDY

To evaluate the clinical-psychological and polysomnographic features of individuals with high sleep reactivity to stress.

METHODS

Study design. Inclusion in the study was conducted among patients 18–75 years old who applied to the consulting and diagnostic department of the Almazov National Medical Research Centre of the Ministry of Health of Russia with complaints of sleep disorders, in whom the Insomnia Severity Index [4] exceeded 15 points. In addition, volunteers without relevant complaints were included in the study as a comparison group. All study participants completed a questionnaire including:

- The Ford Insomnia Response to Stress Test (FIRST) was used to assess sleep reactivity to stress [2];
- subjective assessment of the main sleep parameters over the last month, which was performed using the Pittsburg questionnaire [5] with a total score;
- assessment of insomnia severity using the Insomnia Severity Index [4];
- assessment of clinical and psychological features using the Integrative Anxiety Test [6]. The questionnaire consists of 30 questions with answers on the incidence rate of emotional states recently ("never", "rarely", "often", "almost all the time") with calculation of the sum of scores and division of the questionnaire into subscales of state and trait anxiety. The obtained "raw" scores are converted into standard ten (sten) (from 1 to 9): a score on the general anxiety scale below 4 stens corresponds to a low level of anxiety, 4–6 – to norm, 7 stens and above – to a high level of anxiety;
- assessment of neurotization according to the Scale for psychological express diagnostics of the neuroticism level (NL) [7].

Further, objective sleep assessment by polysomnography (PSG) was performed on the Embla N7000 device (Natus, USA) without medical supervision during one night with assessment of the main sleep characteristics as per the AASM 2.5 rules [8]. Patients with significant acute and chronic comorbidities, including those taking medications that could significantly affect the estimated sleep parameters, were not included in the study. The exclusion criterion was concomitant sleep disorders detected by PSG results (sleep apnea-hypopnea index > 15/h, periodic limb movement index (PLMI) > 15/h). Based on the results of Ford's questionnaire, the subjects were divided into groups with low (< 18 points) and high reactivity (≥ 18 points) [2].

The study was performed in the Almazov National Medical Research Centre of the Ministry of Health of Russia (St. Petersburg) from February 2020 to May 2022. The research report was approved at the meeting of the local ethical committee of the Almazov National Medical Research Centre of the Ministry of Health of Russia No. 02–20 dated February 17, 2020. All subjects signed informed consent to participate in the study prior to the report procedures.

Statistical analysis

The following software was used to analyze statistical data: Statistica v. 8 (StatSoft Inc., USA). The following statistical procedures for analyzing empirical data were used: descriptive statistics (auxiliary indicators for describing the results of other procedures – mean and median), Shapiro – Wilk test (for assessing the normality of distribution and choosing the methodology of intergroup comparison), Student's t-test (applied to parameters having normal distribution and presented in a metric or interval scale) and Mann – Whitney U test (for cases when normal distribution was not observed or the scale was ranked) for comparing quantitative variables, Fisher's exact test for qualitative parameters. The statistical significance level was taken as $p < 0.05$.

STUDY RESULTS

A total of 34 subjects were examined. According to Ford's questionnaire, a high level of sleep reactivity to stress was found in 27 people (76.5 %), of which 8 (23.5 %) were men, with all men having a high level of reactivity. The mean age (Table 1) (35.1 ± 15.5 and 34.9 ± 15.6 years) and other sociodemographic parameters did not differ between the studied groups. The median reactivity level was 24 points, with 26 (10–33) points among those with insomnia, and 22 (13–29) points among those without significant complaints ($p = 0.009$).

When assessing psychological status (Table 2), higher levels of trait anxiety ($p = 0.001$) and state anxiety ($p = 0.002$) were found in the highly reactive group of respondents. In addition, the results of the ITT scales were analyzed. Subjects in the high reactivity group demonstrated higher levels on the following subcomponents of trait anxiety: "emotion-

TABLE 1
SOCIAL AND DEMOGRAPHIC CHARACTERISTICS OF SURVEY GROUPS

Parameters	Total	Low reactivity group (*n* = 7)	High reactivity group (*n* = 27)	*p*
Age	34.96 ± 15.34	35.14 ± 15.53	34.92 ± 15.62	0.739
Gender:				
male	8 (23.5 %)	0 (0 %)	8 (29.6 %)	0.160
female	26 (76.5)	7 (100 %)	19 (70.4 %)	
Education:				
higher	17 (50 %)	2 (28.6 %)	15 (55.6 %)	0.157
secondary	11 (32.35 %)	2 (28.6 %)	9 (33.3 %)	
vocational secondary	6 (17.65 %)	3 (42.8 %)	3 (11.1 %)	
Job:				
employed	24 (70.6 %)	5 (71.4 %)	19 (70.4 %)	1.000
unemployed	10 (29.4 %)	2 (28.6 %)	8 (29.6 %)	
Smoking:				
smokers	8 (23.5 %)	2 (28.6 %)	6 (22.2 %)	1.000
non-smokers	26 (76.5 %)	5 (71.4 %)	21 (77.8 %)	
Comorbidities:				
hypertension	1 (3 %)		1 (4 %)	0.405
diabetes mellitus	1 (3 %)	1 (14 %)		
others	16 (47 %)	2 (28 %)	14 (52 %)	
Alcohol:				
no	9 (26.5 %)	3 (43 %)	6 (22 %)	0.634
1–2 times a month	17 (50 %)	3 (43 %)	14 (52 %)	
on a regular basis	8 (23.5 %)	1 (14 %)	7 (26 %)	
Physical activity:				
No	2 (6 %)	1 (14 %)	1 (4 %)	0.292
occasionally	11 (32 %)	3 (43 %)	8 (30 %)	
on a regular basis	21 (62 %)	3 (43 %)	18 (66 %)	
BMI	24.79 ± 9.85	23.16 ± 5.64	25.21 ± 10.72	0.496
Insomnia severity index > 5 points	15 (44.1 %)	1 (14.3 %)	14 (51.8 %)	0.104
Insomnia severity index, points	12 (2–25)	7 (2–17)	16 (3–25)	0.127

al discomfort" ($p = 0.047$), "asthenic component of anxiety" ($p = 0.009$), "phobic component" ($p = 0.033$), and "anxious evaluation of perspective" ($p = 0.002$). Levels of state anxiety were also higher in the high reactivity group according to its individual components: "emotional discomfort" ($p = 0.029$), "asthenic component" ($p = 0.049$).

When assessing neuroticism level (NL), a predominance of higher values was found in subjects with high reactivity

TABLE 2

PSYCHOLOGICAL INDICATORS IN THE LOW AND HIGH REACTIVITY OF SLEEP TO STRESS GROUPS

Parameters	Low reactivity group, Me (Q1; Q3)	High reactivity group, Me (Q1; Q3)	*p*
ITT_T_st, sten	5 (5; 6)	8 (7; 9)	0.001
ITT_T_ED_st, sten	6 (5; 8)	7 (7; 9)	0.047
ITT_T_AST_st, sten	6 (4; 8)	8 (6; 9)	0.009
ITT_T_PHOB_st, sten	5 (3; 6)	7 (5.75; 8)	0.033
ITT_T_EP_st, sten	5 (4; 6)	7.5 (6; 9)	0.002
ITT_T_SP_st, sten	4 (1; 7)	5 (2.75; 7.25)	0.252
ITT_S_st, sten	1 (1; 2)	5 (2.5; 6)	0.002
ITT_S_ED_st, sten	1 (1; 1)	3 (1; 6)	0.029
ITT_S_AST_st, sten	5 (1; 6)	7 (6; 8.5)	0.049
ITT_S_PHOB_st, sten	1 (1; 3)	4 (1; 6)	0.110
ITT_S_EP_st, sten	1 (1; 5)	4 (2.5; 5.5)	0.121
ITT_S_SP_st, sten	1 (1; 5)	4 (1; 5)	0.425
Insomnia severity index, points	7 (4; 7)	16 (8; 18)	0.058
PSQI_quality of sleep, points	1 (1; 2)	2 (1; 3)	0.048
PSQI_total score, points	6 (4; 8)	10 (9; 15)	0.008

Note. Structure components of trait anxiety: ITT_T_st – trait anxiety; ITT_T_ED_st – emotional discomfort; ITT_T_AST_st – asthenic; ITT_T_PHOB_st – phobic; ITT_T_EP_st – anxious evaluation of perspective; ITT_T_SP_st – social protection. Structure components of state anxiety: ITT_S_st – state anxiety; ITT_S_ED_st – emotional discomfort; ITT_S_AST_st – asthenic; ITT_S_PHOB_st – phobic; ITT_S_EP_st – anxious evaluation of perspective; ITT_S_SP_st – social protection. PSQI – Pittsburgh Sleep Quality Index.

TABLE 3

SLEEP PARAMETERS BY PSG IN THE GROUPS OF HIGH AND LOW REACTIVITY OF SLEEP TO STRESS

Parameters	Low reactivity, Me (Q1; Q3)	High reactivity, Me (Q1; Q3)	*p*
Duration of sleep, min	450.5 (441.6; 474)	383.5 (344; 453)	0.086
Sleep efficacy, %	93 (78.5; 94)	77.9 (65; 85.4)	0.004
Wake time after sleep onset, min	22 (13.2; 24)	85.8 (34.8; 159.8)	0.013
Sleep latency, min	13.9 (6; 43)	28.3 (9.8; 65)	0.273
NREM-sleep stage 1 representation, %	3.5 (2.8; 8)	5 (4.4; 14)	0.036
NREM-sleep stage 2 representation, %	53.5 (49.8; 56)	46.7 (36.5; 53.8)	0.141
NREM-sleep stage 3 representation, %	23.5 (15; 28.4)	16.6 (13; 21)	0.026
REM-sleep representation, %	15.8 (8; 23)	14.7 (10.4; 20.5)	0.961

Note. NREM – non-rapid eye movement; REM – rapid eye movement.

(47.86 ± 24.96; 8.11 ± 38.16; $p = 0.014$). Individuals with low sleep reactivity to stress had a very low NL, indicating a low probability of neuroticism (ranging from 6 % in men to 13 % in women), whereas the group with high sleep reactivity to stress had an indeterminate NL, with a 49–50 % probability of neuroticism. Both subjective sleep quality score ($p = 0.048$) and total score ($p = 0.008$) as per the Pittsburgh Sleep Quality Index were higher in the low sleep reactivity to stress group, but no statistically significant differences were found on the Insomnia Severity Index. The results obtained in the questionnaire are consistent with objective sleep indicators in this group (Table 3): lower sleep efficien-

cy (p = 0.004) mainly due to impaired sleep maintenance (longer wakefulness after sleep onset, p = 0.013) and less deep sleep (1.5 % greater representation of the 1st stage of non-rapid eye movement (p = 0.036) and less representation (as a percentage) of the 3rd stage of non-rapid eye movement (p = 0.026)).

DISCUSSION

In this work, we evaluated the clinical and psychological characteristics of 34 volunteers and patients with complaints of sleep disorders, dividing them into groups with low and high sleep reactivity to stress, which was found in 4/5 of the respondents. Screening techniques for assessing anxiety and neuroticism were chosen to assess psychological status, since individuals with high anxiety are more likely to suffer from sleep disorders, and anxiety is one of the factors in the structure of the Ford scale, with the likelihood of developing sleep disorders before an important event (questions 1, 8, 9) [2]. The findings of high levels of trait anxiety as per the ITT assessing perspective taking, hyperactivation, and phobias in highly reactive individuals are consistent with the notion of predisposing factors for the development of insomnia [9]. And questions assessing the asthenic component of trait anxiety describe typical complaints of persons with insomnia. In contrast to trait anxiety, there were no differences for the "anxious evaluation of perspective" and "phobic component" when assessing state anxiety. The "social protection" component is optional in the anxiety assessment and was not significant for either trait or state anxiety. The level of state anxiety was below normal in the low reactivity group, and average in the high reactivity group, with statistically significant differences on the components of emotional discomfort and asthenia. Thus, the results obtained at this stage of the study are consistent with the data of works describing the association of a high level of sleep reactivity to stress and the severity of anxiety [10, 11], as well as symptoms of insomnia [12, 13]. Current standards for the diagnosis of insomnia do not require instrumental confirmation of sleep disturbance by PSG; it is used to exclude comorbid sleep disturbances [9]. Our data from a previous analysis of objective sleep characteristics of individuals with insomnia symptoms showed no statistically significant differences in PSG scores [14] when compared to healthy volunteers. The changes in PSG detected in our study may be a response to polysomnographic examination, as it is known about the «first night effect», when some people sleep worse on the first night of PSG and better on the second and subsequent nights [15]. At the same time, impaired sleep quality in highly reactive individuals may indicate a more severe sleep disturbance than insomnia. Drake C. data from a prospective 1-year follow-up cohort of individuals without symptoms of insomnia or depression suggest a 3-fold increased risk of developing insomnia among individuals with high Ford Insomnia Response to Stress Test, even after adjusting for stress exposure and sociodemographic factors. Increased sleep latency was also found among those who developed insomnia [16]. A limitation of the study is the small sample size and lack of prospective follow-up. At the same time, a comprehensive assessment of anxiety components and objective sleep assessment by PSG allows us to evaluate the characteristics of individuals with high sleep reactivity to stress.

CONCLUSION

Within the framework of the conducted work the following features of the subjects of the group of high sleep reactivity to stress were revealed: higher levels of anxiety as an individual-typological property, anxiety as a state, neuroticism, as well as worse subjective and objective sleep indices. Assessment of sleep reactivity to stress using the Ford Insomnia Response to Stress Test may be a practical tool for predicting objective sleep disturbances characteristic of insomnia. Prospective follow-up is required to assess the prognostic value of the development of insomnia in individuals with different sleep reactivity to stress.

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Conflict of interest

The authors of this article declare the absence of a conflict of interest.

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